Jeffrey Cotsifas
<cotsifas@pacificecorisk.com>

07/20/2005 12:21 PM

To Dwinell David <david.l.dwinell@spd02.usace.army.mil>,

cc Davis Clyde <Clyde.R.Davis@spd02.usace.army.mil>, Chan Margaret <Margaret.Chang@spd02.usace.army.mil>, Sweatt Shelah <Shelah.Sweatt@spd02.usace.army.mil>, Brian

bcc

Subject Levin-Richmond Terminal SAP

1 attachment

05_July18_Levin_SAP.pdf

Dear David:

On behalf of Mr. Jim Cannon of Levin-Richmond Terminal Corporation and Mr. Michael Cheney of Michael Cheney Associates, I have attached a pdf file of our Sampling and Analysis Plan (SAP) "Sediment Characterization Sampling and Analysis Plan for the Levin-Richmond Terminal Located in Richmond Inner Harbor" for review at the July 27 DMMO meeting; hard copies are in the mail. As described in this SAP, the purpose of this sampling event is to characterize ~20,000 cubic yards of dredged material to determine if it will be suitable for disposal at the Alcatraz Disposal Site located in San Francisco Bay.

If you have any questions, please give me a call at (925) 313-8080. I look forward to hearing from you.

Regards,
Jeffrey Cotsifas
President

Pacific EcoRisk
835 Arnold Drive, Suite 104
Martinez, CA 94553
P: (925) 313-8080
F: (925) 313-8080
cotsifas@pacificecorisk.com

Sediment Characterization Sampling and Analysis Plan for the Levin-Richmond Terminal Located in Richmond Inner Harbor

Prepared for

Levin-Richmond Terminal Corporation
402 Wright Avenue
Richmond, CA 94804

Prepared by

Pacific EcoRisk
835 Arnold Dr., Suite 104
Martinez, CA 94553

July 2005

PACIFIC ECORISK
ENVIRONMENTAL CONSULTING & TESTING

Sediment Characterization Sampling and Analysis Plan for the Levin-Richmond Terminal Located in Richmond Inner Harbor

Prepared for

Levin-Richmond Terminal Corporation
402 Wright Avenue
Richmond, CA 94804

Prepared by

Pacific EcoRisk
835 Arnold Dr., Suite 104
Martinez, CA 94553

July 2005

Table of Contents

Appendices

List of Figures

List of Tables

List of Acronyms

ASTM	American Society for Testing and Materials
Bay	San Francisco Bay
BCDC	Bay Conservation and Development Commission
CAS	Columbia Analytical Services, Inc.
COC	Chain-of-custody
CV	Coefficient of Variation
DGPS	Differential Global Positioning System
DMMO	Dredged Material Management Office
GPS	Global Positioning System
ITM	Inland Testing Manual (USEPA/USACE 1998)
JBA	John Brezina and Associates
LRTC	Levin-Richmond Terminal Corporation
LTMS	Long Term Management Strategy
MLLW	Mean lower low water
PER	Pacific EcoRisk
QA/QC	Quality assurance/quality control
RSD	Relative Standard Deviation
RWQCB	Regional Water Quality Control Board
SAP	Sampling and analysis plan
SLC	State Lands Commission
SOP	Standard operating procedures
TEG	TEG Oceanographic Services
TOC	Total Organic Carbon
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency

Distribution List

Dwinell, Dave (4 copies)
U.S. Army Corps of Engineers
333 Market Street, Suite 809
San Francisco, CA 94105-2197

Ross, Brian
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA 94105-3919

Goeden, Brenda
San Francisco Bay Conservation and Development Commission
50 California St., Suite 2600
San Francisco, CA 94111-6080

Christian, Beth
San Francisco Regional Water Quality Control Board
1515 Clay St., Suite 1400
Oakland, CA 94612-1413

Isaac, George
California Department of Fish & Game
20 Lower Ragsdale Drive, Suite 100
Monterey, CA 93940

Woodbury, David
National Marine Fisheries Service, Southwest Region
777 Sonoma Ave. #325
Santa Rosa, CA 95404

Oetzel, Donn
State Lands Commission
100 Howe Ave, #100 South
Sacramento, CA 95825-8202

Cheney, Michael
6630 Heartwood Drive
Oakland, CA 94611

Jim Cannon
Levin-Richmond Terminal Corporation
402 Wright Avenue
Richmond, CA 94804

1. INTRODUCTION

The Levin-Richmond Terminal Corporation (LRTC), located in Point Richmond, CA, in the Richmond Inner Harbor Channel (Figures 1-1 and 1-2) is currently seeking a 10-year permit from the U.S. Army Corps of Engineers (USACE), and 5 year permits from the Bay Conservation and Development Commission (BCDC) and San Francisco Bay Regional Water Quality Control Board (RWQCB) for maintenance dredging of their berth areas.

This Sampling and Analysis Plan (SAP) is being prepared in support of maintenance dredging in which the LRTC is proposing to dredge depositional material from it's loading terminal berth and an adjacent berth area operated by Shore Terminal; full Inland Testing Manual (ITM) testing will be performed to satisfy permit requirements. The material is proposed for removal in order to appropriately maintain essential Terminal operations. This SAP has been developed in accordance with currently applicable guidance, and establishes the general approach to sampling and assessment of sediments proposed for dredging with aquatic disposal being the preliminarily preferred disposal option.

To accommodate vessel transit and berthing, LRTC requires dredging of its berth area to a depth of –39.0 ft MLLW + 2.0 ft over-dredge; it is proposed that this area be sampled and tested to a total depth of –41.0 ft MLLW. The adjacent berth area will require dredging to a depth of –38.0 ft MLLW + 1.0 ft over-dredge; it is proposed that this area be sampled and tested to a total depth of –39.0 ft MLLW. The proposed maintenance depth and estimated volumes of dredged material for each area, including over-depth, are summarized in Table 1-1. It is proposed that the dredged material from this episode and any subsequent episodes will be disposed at the Alcatraz disposal site (SF-11).

Table 1-1. Proposed maintenance dredging for the Levin-Richmond Terminal Corporation

Area	Permitted Depth (ft MLLW)	Estimated Volume (yds^3)	Over-depth (ft)	Estimated Volume (yds^3)	Maintenance Depth (ft MLLW)	Total Estimated Volume (yds^3)
1	-39.0	831	+2	4670	-40	5501
2	-38.0	11922	+1	2560	-39	14482
Totals	**-**	**12753**	**-**	**7230**	**-**	**19983**

1.1 Objectives of the Sediment Investigation

The purpose of this investigation is to evaluate the proposed dredged material to determine whether it will represent an adverse impact during removal operations and placement at the SF-11 Disposal Site. The procedures for sediment sample collection, sample processing and preparation, physical and chemical analyses, biological testing and data analyses are presented in this SAP. The specific objectives of the SAP scope of work are as follows:

- Collect core samples from within the designated sampling areas following field protocol detailed in the SAP;
- Conduct chemical and biological analyses to determine whether sediments are suitable for unconfined aquatic disposal (SUAD), with bioaccumulation testing being deferred pending analysis of the dredged material chemistry data.

Guidance concerning necessary sampling and analytical protocols, quality assurance/quality control (QA/QC) procedures, and data interpretation is found in:

- *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S, Inland Testing Manual* (ITM; USEPA/USACE 1998);
- Public Notice 01-1: Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region;
- Public Notice 99-4: Proposed Guidance for Sampling and Analysis Plans (Quality Assurance Project Plans) for Dredging Projects within the USACE San Francisco District;
- Public Notice 93-2: Testing Guidelines for Dredged Material Disposal at San Francisco Bay Sites;
- The Dredged Material Management Office (DMMO) review process.

1.2 Overview of Field Activities and Analyses

A total of 5 sediment cores will be collected from Site 1, and 5 sediment cores will be collected from Site 2; these cores will be collected using a vibra-corer (Figures 1-3, 1-4, and 1-5). A sub-sample of the sediment from each core will be archived for subsequent analyses of the individual core sediment, if needed. Proportional aliquots of the sediment from the cores collected from each site will be composited; a sample of each composite sediment will be submitted for chemical and conventional analyses and biological testing (toxicity tests only). The results of these analyses will be used to determine the suitability of the proposed sediments for disposal at the SF-11 Disposal Site.

1.3 DMMO Agency Review and Permitting

The federal and state agencies responsible for regulating dredged material programs in the San Francisco Bay area include the USEPA Region 9 office, the USACE, the RWQCB, the BCDC, and the State Lands Commission (SLC).

Under a previous permit or certification from each of the DMMO Agencies, maintenance dredging has been performed at the LTRC and Shore Terminal berths and surrounding channel areas within the Richmond Inner Harbor; permits and other supporting documentation for previous maintenance dredging events performed at this facility were not available at the time of this SAP preparation. This document has been prepared for use in support LRTC's new permit and first maintenance dredging event under this new permit.

Figure 1-1. Location Map: Levin-Richmond Terminal

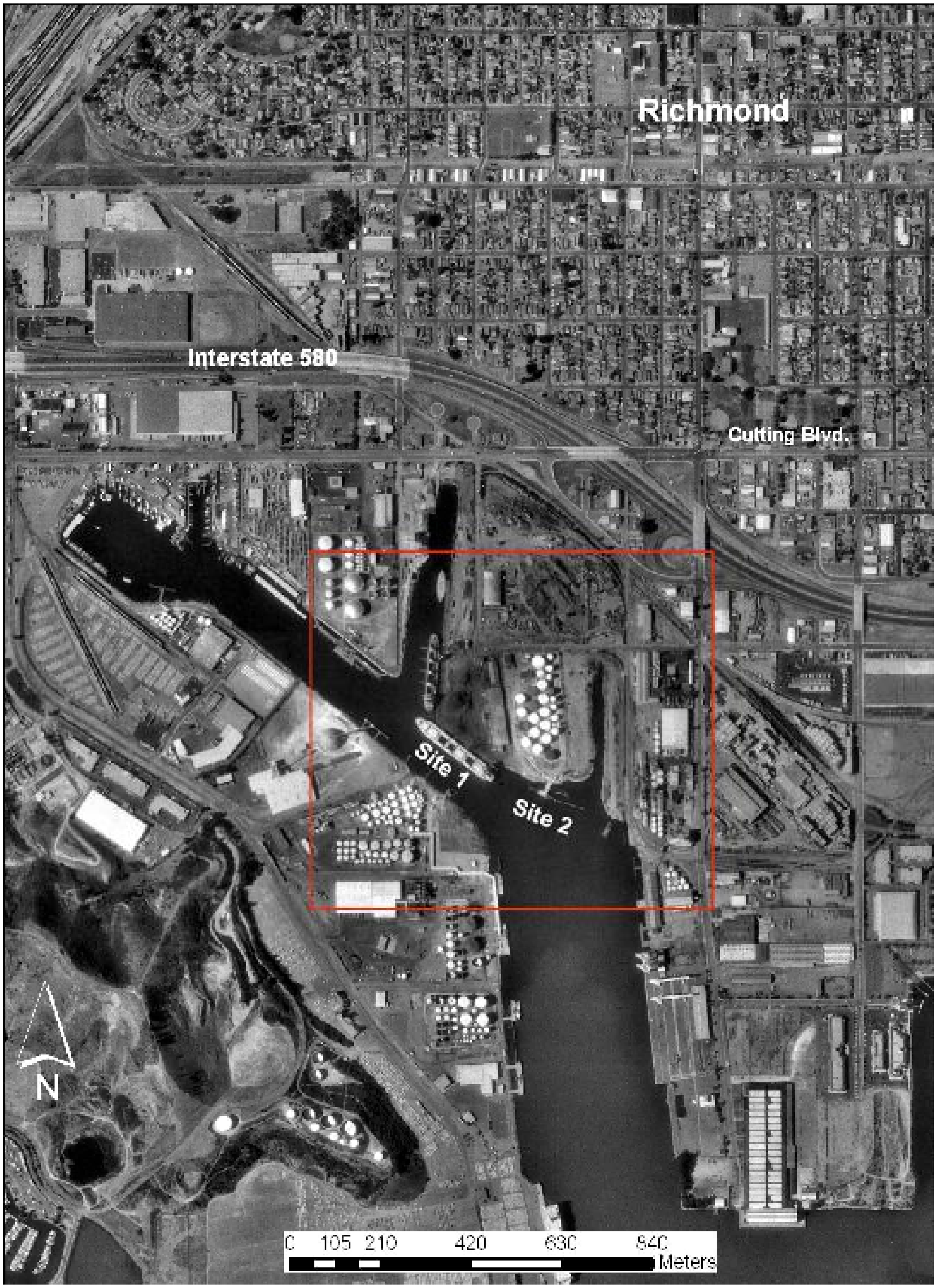


Figure 1-2. Vicinity Map: Levin-Richmond Terminal

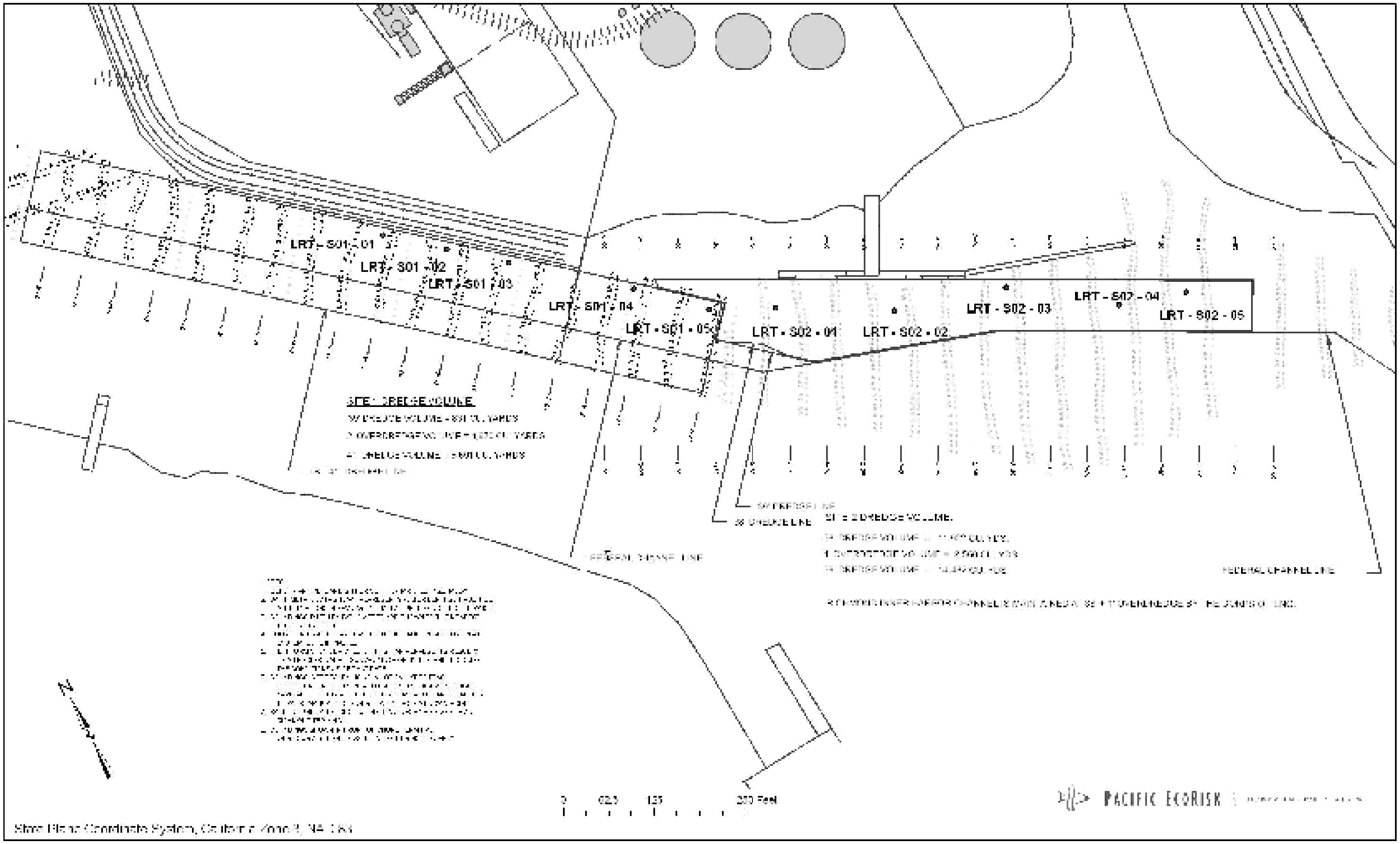


Figure 1-3. Levin-Richmond Terminal/Shore Terminal Sediment Core Locations

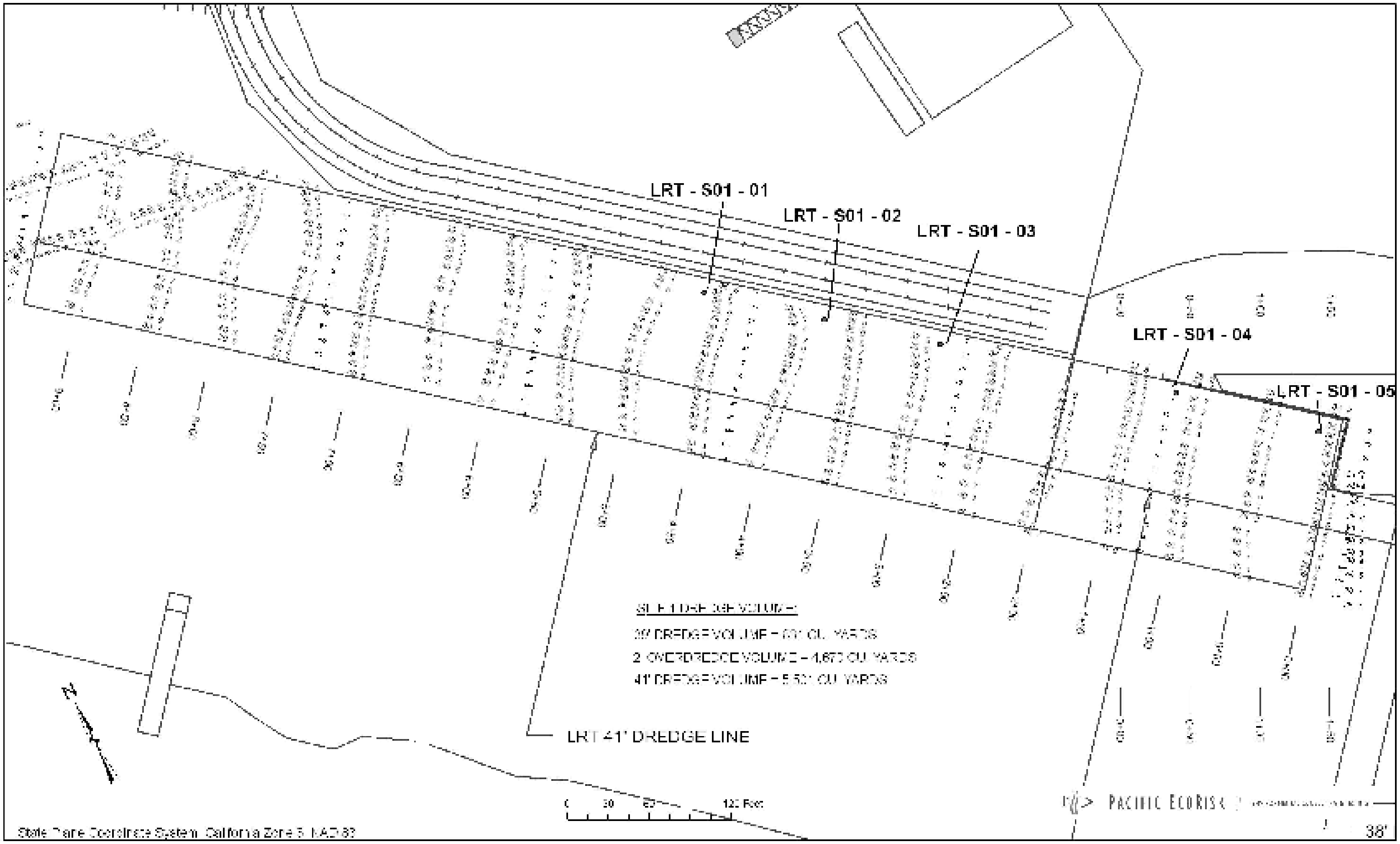


Figure 1-4. Site 1 (Levin-Richmond Terminal) Sediment Core Locations

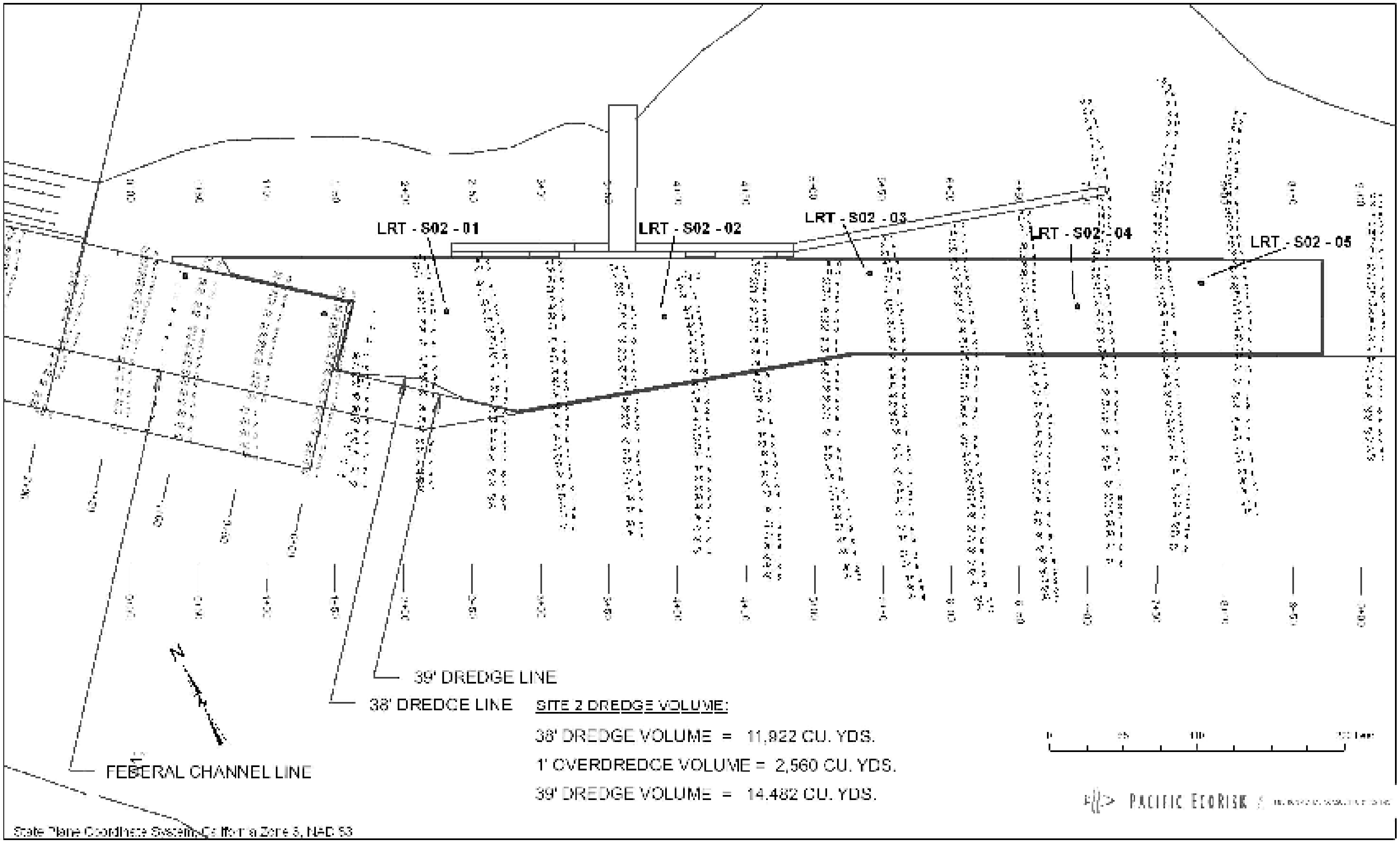


Figure 1-5. Site 2 (Shore Terminal) Sediment Core Locations

2. PROJECT MANAGEMENT AND RESPONSIBILITIES

2.1 Program and Field Activities

Mr. Mike Cheney of Michael Cheney Associates will be the Project Manager on behalf of LRTC. The Sampling and Analysis Project Manager for the primary contractor is Mr. Jeff Cotsifas of Pacific EcoRisk (PER), assisted by Dr. R. Scott Ogle. Mr. Cotsifas will be responsible for overall project coordination, including production of all project deliverables, collection and submittal of environmental samples to the designated laboratories for chemical and physical analyses, and administrative coordination to assure timely and successful completion of the project. Mr. Cotsifas will also be responsible for all decisions concerning sample collection, for QA/QC oversight, and ensuring that appropriate protocols for decontamination, sample preservation, and holding times are observed. Mr. Cotsifas and Dr. Ogle will be involved in all aspects of this project, including preparation, review, and approval of the SAP, and review and interpretation of all analytical results. The project management organization is illustrated in Figure 2-1.

All field activities will be performed under the direction of Mr. Cotsifas. Sediment cores will be collected by TEG Oceanographic Services (TEG). During collection of cores, the sampling vessel will be staffed with a captain, operating crew, and 2 field scientists. Mr. Mark Mertz of TEG will captain the sampling vessel, and will be responsible for location control and positioning, and providing vibracorer and operating crew. PER will supply a Field Manager and Field Scientist. Reference sediments will be collected by John Brezina and Associates (JBA); Mr. Brezina of JBA will captain the sampling vessel, and will be responsible for collection of reference sediment from the SF-10 and SF-11 Disposal Site reference stations.

2.2 Project Management

A Laboratory Project Manager will be appointed from each laboratory. Laboratory Project Managers will provide analytical support and will be responsible for ensuring that all laboratory analyses meet the project data quality objectives and other specifications required by ITM guidance, regional guidance, and the DMMO review process. The Laboratory Project Managers are as follows:

Project Management and Bioassay Testing:
Mr. Jeffrey Cotsifas
Pacific EcoRisk
835 Arnold Drive, Suite 104
Martinez, CA 94553
Telephone: (925) 313-8080
Facsimile: (925) 313-8089

Sediment Chemistry and Conventional Analyses:
Ms. Lynda Huckestein
Columbia Analytical Services, Inc.
1317 South 13th Ave.
Kelso, WA 98626
Telephone: (360) 577-7222
Facsimile: (360) 636-1608

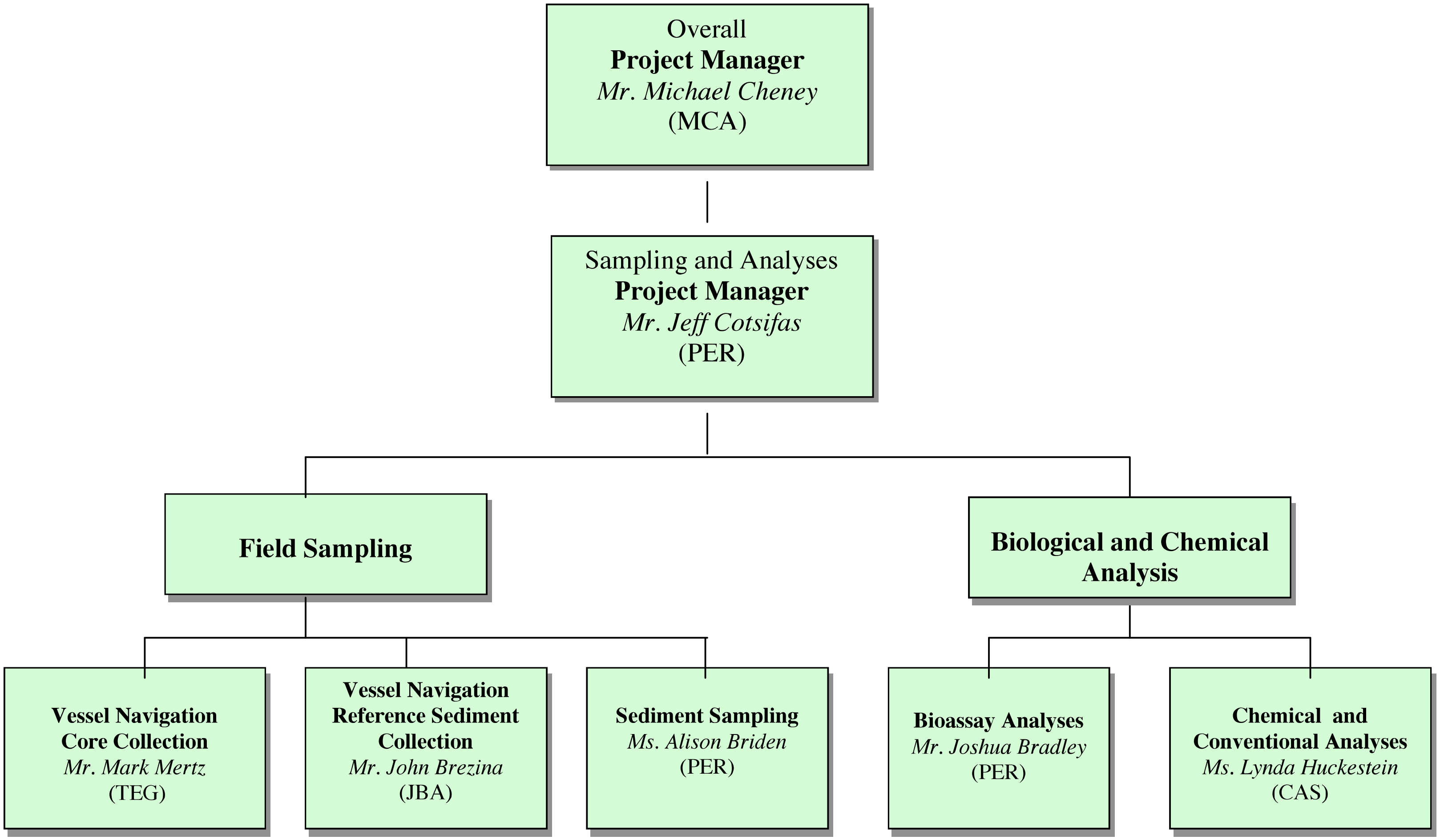
Reference Sediment Sampling Vessel Operation:
Mr. John Brezina
John Brezina & Associates
P.O. Box 25
Dillon Beach, CA 94929
Telephone: (707) 878-2853
Facsimile: (707) 878-2347

Vibracore Sampling Vessel Operation:
Mr. Mark Mertz
TEG Oceanographic Services
216 Florence Drive
Santa Cruz, CA 95061
Telephone: (831) 684-2749
Facsimile: (831) 684-2748

The contract laboratories and vessel operators are expected to meet the following minimum technical requirements as specified in their negotiated subcontracts with PER:

1. Adherence to the methods outlined in the SAP, including those methods referenced for each analytical procedure, as per ITM and DMMO requirements;
2. Deliver electronic data files as specified;
3. Meet all reporting requirements;
4. Implement and comply with QA/QC procedures required by ITM and DMMO guidelines;
5. Allow PER to perform laboratory and data audits;
6. Meet turnaround times for deliverables.

Figure 2-1. Project Organizational Chart



3. REVIEW OF EXISTING DATA

3.1 Site History

3.1.1 Adjacent Water and Land Uses

The LRTC Loading Terminal is located in the Richmond Inner Harbor, Richmond, CA. The eastern end of the facility is bordered by 8th street. Manson Construction is located northwest of the terminal facility; Kinder Morgan and ConocoPhillips are located directly across the channel.

3.1.2 Spills and Discharges

To LRTC's knowledge, there have been no spills or other environmental events on their property that would materially change the quality of the Terminal Berths sediments. All storm drains enter into a canal north of Site 2. The LRTC storm drains are regulated by the RWQCB under a NPDES permit; all discharges from these drains have met NPDES permit requirements.

3.2 Recent Testing History

Under a previous permit or certification from each of the DMMO Agencies, maintenance dredging has been performed at the LTRC and Shore Terminal berths and surrounding channel areas within the Richmond Inner Harbor; permits and other supporting documentation for previous maintenance dredging events performed at this facility were not available at the time of this SAP preparation. This document has been prepared in support of LRTC's new permit and first maintenance dredging event under this new permit.

4. SAMPLING PROGRAM: SEDIMENT COLLECTION AND HANDLING

4.1 Sampling Platform

TEG will provide the sampling vessel and all equipment necessary for the safe operation of the boat to support sampling operations. The sampling vessel is 35-ft long trawler vessel with a 4-ton belt hydraulic crane for deploying and retrieving sampling equipment; operation of the sampling vessel will be the responsibility of Mr. Mark Mertz. The vessel is powered by twin V12 diesel engines, has an AC/DC electrical system and approximately 35 x 20 ft^2 of clear aft deck work space for processing samples. The vessel conforms to U.S. Coast Guard safety standards.

Collection of sediment cores will be performed by both TEG and PER Field Scientists. Sediment cores will be collected, physically evaluated, and stored in appropriate sample containers on board the vessel.

4.1.1 Reference Sediment Collection

Collection of sediment will be performed by Mr. Brezina of John Brezina Associates (JBA). JBA will provide the sampling vessel and all equipment necessary to safely support sampling operations. The sampling vessel is a 24 ft long cuddy cabin vessel with a mast and boom system for deploying and retrieving sampling equipment; operation of the sampling vessel will be the responsibility of Mr. John Brezina. The vessel is powered by twin 140 horsepower outboards mounted on Sea-drives, has a 12V electrical system and approximately 64 ft^2 of usable work space, including a raised table for processing samples. The vessel conforms to U.S. Coast Guard safety standards.

4.2 Navigation and Vertical Control

Location control will be the responsibility of TEG under the direction of Mr. Mertz and will be accomplished-using a differential global positioning system (DGPS). The navigation systems will be calibrated to a known survey monument in the project area. The navigation system will be used to guide the vessel to predetermined core sample locations and to identify the exact sampling location where the corer strikes the bottom. The required accuracy for horizontal positioning is ± 3 m.

Upon locating the sampling position, station depth will be measured using an on-board calibrated fathometer or a lead line, and tidal elevation will determined relative to harbor datum MLLW. The tidal elevation will be subtracted from the measured depth to determine the sediment surface elevation relative to MLLW. All vertical elevations will be reported to the nearest foot relative to zero (0) ft MLLW, harbor datum.

In the event that the DGPS is not functioning properly because of local interference, station locations will be positioned using a laser range finder to record the perpendicular distance from at least two stationary markers located within the harbor. Interference with DGPS is not expected to be a problem at this location.

4.3 Station Locations

The objective of the sampling station selection and the subsequent compositing design is to provide samples that represent, as accurately as possible, the physical, chemical, and toxicological characteristics of the sediments to be dredged. Results of the most recent bathymetric survey were used to assist in choosing core sample stations (Figures 1-3, 1-4 and 1-5). Sampling locations were chosen in areas that were representative in depth of the surface sediment above the proposed dredging depth at intervals within the berth to provide appropriate general coverage; proposed sample locations and estimated core depths are provided below in Table 4-1.

Table 4-1. Locations of sampling stations and estimated core depth

Site	SAMPLE ID	Latitude* (deg-min-sec)	Longitude* (deg-min-sec)	MUDLINE ELEVATION (ft MLLW)	PROPOSED PROJECT DEPTH + OVER-DEPTH (ft MLLW)	ESTIMATED CORE LENGTH (ft)
1	LRT-S01-01	37° 55’ 8.6’’	122° 21’ 58.3’’	-38.2	-41	2.8
	LRT-S01-02	37° 55’ 8.0’’	122° 21’ 57.5’’	-38.0	-41	3.0
	LRT-S01-03	37° 55’ 7.5’’	122° 21’ 56.6’’	-37.3	-41	3.7
	LRT-S01-04	37° 55’ 6.4’’	122° 21’ 54.9’’	-38.7	-41	2.3
	LRT-S01-05	37° 55’ 5.4’’	122° 21’ 52.9’’	-37.0	-41	4.0
2	LRT-S02-01	37° 55’ 4.6’’	122° 21’ 51.1’’	-33.3	-39	5.7
	LRT-S02-02	37° 55’ 3.3’’	122° 21’ 47.6’’	-33.0	-39	6.0
	LRT-S02-03	37° 55’ 3.1’’	122° 21’ 46.4’’	-32.3	-39	6.7
	LRT-S02-04	37° 55’ 5.7’’	122° 21’ 53.9’’	-31.3	-39	7.7
	LRT-S02-05	37° 55’ 4.2’’	122° 21’ 49.2’’	-27.2	-39	11.8

*State Plane Coordinate System, California Zone 3, NAD 83

4.4 Collection of Sediment Core Samples

Five sediment cores will be collected from Site 1, and 5 sediment cores will be collected from Site 2 (Figure 1-3); these samples will be collected using a vibra-corer. The sediment core sampling procedure is summarized in this section. Greater detail is provided in the Standard Operating Procedure (SOP) for sediment core collection (Appendix C).

Sediment will be collected using a vibra-corer. All cores will be collected to the dredge depth, or refusal. Upon completion of core penetration at a station, the position will be recorded and the sampler recovered.

Once the corer is on deck, the sediment core will be extracted from the corer barrel. The core will be examined to determine compliance with acceptability criteria as follows:

1. The core penetrated and retained material to project depth, or to refusal,
2. Cored material does not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube,
3. There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube, resulting in incomplete core collection.

If core acceptance criteria are not achieved, the core will be rejected and the procedure repeated until acceptance criteria are met. If 3 repeated attempts within 25-50 ft in either direction of the proposed location do not yield a core that meets the appropriate acceptance criteria, the Sampling and Analysis Project Manager or field lead will select an alternate station of similar representability.

4.4.1 Collection of Reference Sediments

Reference sediments will be collected by JBA. Disposal site reference sediments will be collected from both the SF-10 and SF-11 Disposal Sites. The reference sediments will be collected as ‘grab’ samples.

4.4.2 Collection of Site Water

Ambient surface water will be collected from within the berth area for use in preparing the sediment elutriate for testing. Briefly, site water will be collected from approximately 3 ft below the surface using a battery-operated peristaltic pump fitted with tygon tubing. Site water will be “pre-pumped” through the tubing for approximately 3 minutes before the sample is collected. Water will then be pumped into a 10-L polypropylene carboy, with the carboy being pre-rinsed 3 times with site water before the site water sample is collected. After the site water samples are collected, the carboys will be sealed, labeled, and stored on ice, until delivered to the bioassay laboratory.

If the salinity of either site water is $\leq$28 ppt, the site water will either be adjusted up to a salinity of 30±2 ppt via addition of artificial sea salts prior to use, or clean seawater collected from the U.C. Davis Granite Canyon Marine Laboratory (Carmel, CA) will be diluted to a salinity of 30±2 ppt via addition of reverse-osmosis- de-ionized water for use in the elutriate preparation.

4.5 On-Board Sample Processing and Labeling

Individual cores will be extruded and placed into food-grade polyethylene bags on board the sampling vessel. Physical characteristics of each core will be noted on the individual sediment core collection log. Aboard the vessel, samples will be temporarily stored on ice (or frozen “blue ice”) within insulated coolers.

4.5.1 Station and Sample Identification

Each individual sediment core and composite sediment sample will be assigned a unique alphanumeric identifier using the format described below:

- The first 3 characters will identify the area e.g., LRT = Levin-Richmond Terminal,
- The next 3 characters will identify the Site, e.g., S01 = sampling site #1,
- The next two characters will be used to identify:
  1) the coring location, and
  2) the sequence of collection from that particular site.

  For coring locations and respective individual samples, these two characters will be 01, 02, 03, 04 and 05.

For example, the individual station core samples for Site 1 will be identified as LRT-S01-01, LRT -S01-02, LRT -S01-03, LRT-S01-04, and LRT-S01-05.

4.6 Field Equipment Decontamination Procedure

The deck of the vessel will be rinsed clean with site water between stations. Any sampling equipment that cannot be properly cleaned will not be used for subsequent sampling activity. All sampling equipment coming in contact with collected sediments will be decontaminated between stations using the following procedures:

1. Rinse with site water and wash with scrub brush until free of sediment,
2. Wash with phosphate-free biodegradable soap solution,
3. Rinse with site water taken from 3 ft below the surface.

Acid- or solvent-washing will not be used in the field due to safety considerations and problems associated with rinsate disposal. Residue of acids and solvents on sampling equipment may affect sample integrity for chemical testing. The use of acids or organic solvents on the deck of a vessel may pose a safety hazard to the crew.

4.6.1 Waste Disposal

All sediment remaining on deck after sampling will be washed overboard at the collection site prior to moving to the next sampling station. All disposable sampling materials and personnel protective equipment used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavy-duty garbage bags or other appropriate containers. Disposable supplies will be removed from the vessel by sampling personnel and placed in a normal refuse container for disposal as solid waste.

4.7 Field Data Recording

A complete record of all field activities will be maintained. Record keeping will include documentation of all field activities, and documentation of all samples collected for analysis. The Sampling and Analysis Project Manager, or his designee, will maintain the field logbook. The field logbook will provide a description of all sampling activities, conferences associated with field sampling activities, sampling personnel, weather conditions, and a record of all modifications to the procedures and plans identified in this SAP. The field logbook is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period.

Core collection log sheets will be completed for each sediment core. In addition to standard entries of personnel, date, and time, the log sheet will also include information regarding station coordinates, core penetration, and physical characteristics of the sediment such as texture, color, odor, stratification, and sheens.

4.8 Laboratory Sample Processing/Compositing Plan

Compositing of individual cores will be performed at the PER laboratory facility in Martinez, CA. The sediment from each individual core will be individually homogenized in a stainless-steel bowl or high-density polyethylene (HDPE) container whichever can accommodate the collected volume. A 500-mL sub-sample of each individual core will be archived to allow for additional chemical analyses, if necessary (archived samples will be stored frozen at –20 ± 10˚C for up to one (1) year after sample collection). Representative portions of the remaining homogenized sediment from each of the cores from within a site will be proportionally combined to form a homogenized site composite sample. The remaining sediments from each of the individual cores will be stored at 4˚C.

A 500-mL aliquot of each homogenized site composite will also be archived as described above. Additional aliquots of each site composite sample will then be collected into appropriate sample containers for chemical analyses, and the containers firmly sealed. Sample labels will be filled out with an indelible-ink pen and affixed to the sample containers. Each label will contain the project number, sample identification number, preservation technique, requested analyses, date and time of collection and preparation, and initials of the person preparing the sample. To protect the information on the sample labels, clear tape will be placed around the labeled sample containers. The sample containers will then be placed into a sample freezer and frozen until shipped, with the exception of sediment samples slated for grain size analysis, which will be stored at 4˚C. The remaining homogenized site composite sediment will be stored at 4˚C and will be used subsequently for biological testing.

4.9 Sample Shipping

Prior to shipping to the analytical laboratory, sample containers will be wrapped in bubble wrap and securely packed inside a cooler with ice packs or crushed ice. A temperature blank will be included in each cooler. The original signed COC forms will be placed in a sealed plastic bag and taped to the inside lid of the cooler. Appropriate packaging tape will be wrapped completely around the cooler. A *This Side Up* arrow label will be attached on each side of the cooler, a *Glass-Handle with Care* label will be attached to the top of the cooler, and the cooler will be sealed with custody seals on both the front and the back lid seams.

Sediment samples will be shipped by overnight delivery. Each Laboratory Project Manager at each laboratory will ensure that appropriate chain-of-custody (COC) protocol is followed. The respective laboratory QA Officers will measure and record the temperature of the temperature blank included in each cooler and will specifically note any coolers that do not contain ice packs or are not sufficiently cold upon receipt.

The sub-contracting analytical laboratories will not dispose of any samples for this project until notified by PER in writing.

4.9.1 Chain-of-Custody Protocol

COC procedures will be followed for all samples throughout the collection, handling, and analyses activities. The Sampling and Analysis Project Manager, or a designee, will be responsible for all sample tracking and COC procedures. This person will be responsible for final sample inventory, maintenance of sample custody documentation, and completion of COC forms prior to transferring samples to the analytical laboratory. A COC form will accompany each cooler of samples to the respective analytical laboratories. Each person who has custody of the samples will sign the COC form; a copy of the COC form will be retained in the project file.

Each Laboratory Project Manager will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC forms. The Laboratory Project Manager will contact the Sampling and Analysis Project Manager, or designee, immediately if discrepancies between the COC forms and the sample shipment are discovered.

5. LABORATORY ANALYSES

Chemical and biological analyses will be performed to determine the suitability of the proposed dredged materials for unconfined aquatic disposal. The composited dredged material from each site will be subjected to full ITM testing (as per PN# 01-01 guidance), with bioaccumulation testing being deferred pending analysis of the dredged material chemistry data.

5.1 Chemical and Conventional Analyses

All sediment chemical and conventional analyses will be conducted in accordance with DMMO guidelines. A brief summary of the proposed analyses of bulk sediment is presented below. A detailed list of each analysis, the analytical methods to be used, and the targeted detection limits for the evaluation of sediments are presented in Appendix B. All samples will be maintained according to the appropriate holding times and temperatures for each analysis (presented in Appendix A).

5.1.1 Physical Analyses of Sediments

Each of the sediment samples will be characterized for physical properties:

- **Apparent Grain Size –** The sediment grain size characteristics of each sample will be determined using methods described in Plumb (1981). The frequency distribution of the size ranges (reported in millimeters) of the sediments will be presented in the report and will be summarized as the percentage of sand, silt, and clay fractions;
- **Total Organic Carbon (TOC) -** TOC will be determined by combustion using an Elemental Analyzer;
- **Total Solids -** Total solids will be determined by drying the sample to a constant weight at 103-105°C.

5.1.2 Chemical Analyses of Sediments

Chemical analyses will be performed on each of the sediments. All sediment analytical results will be presented on a dry weight basis (e.g., mg/kg or μg/kg, dry wt). Matrix spikes and sample duplicate analyses will be performed on a site sample. The chemical analyses to be performed will include:

- **Metals**, determined using an Inductively Coupled Plasma Mass Spectrometer (ICP/MS) according to Method 6020; Selenium will be analyzed by GFAA according to SM 7742;
- **PAHs, Chlorinated Pesticides, and PCBs**, extracted using EPA Method 3545 and cleaned-up using EPA Methods 3611 and 3630 (alumina/silica gel). Quantification will be as per a modified Method 8270, and will be performed using a Capillary Gas Chromatograph/Mass Spectrometer (GC/MS);
- **Dissolved sulfides and total ammonia**, determined by Method SM4500;
- **Organotins**, following the method described in Krone, et al (1989). Briefly, this method involves the solvent extraction of samples followed by derivitization using excess hexamethyl magnesium bromide. The precipitate is dissolved in HCl and the solvent

layer is removed and passed through and alumina/silica gel column. Samples are then analyzed using a Capillary GC/MS in the selected ion monitoring (SIM) mode.

5.2 Biological Testing

Bioassays will be conducted to determine the toxicity of the sediment samples according to DMMO regional guidance and appropriate test protocol (i.e., ASTM Methods). Summaries of test conditions for biological testing are presented in Appendix D. Toxicity tests are conducted to determine whether anthropogenic contaminants of concern are present at concentrations that are toxic to biota, and whether removal of the sediment from the site and subsequent disposal at SF-11 poses a risk of toxicity to resident organisms. Both benthic (whole sediment) and water column (sediment elutriate) toxicity tests will be conducted for each site composite sediment. In addition, benthic toxicity tests will be performed on the SF-10 and SF-11 Disposal Site reference samples and the test organisms' "Home" sediments.

Test species selection and test procedures are discussed in the following sections. If the species proposed for testing are not available, or if the DMMO requests testing with different species, an appropriate alternative species will be selected from Tables 11-1, 11-2, or 12-1 in the ITM.

5.2.1 Benthic Sediment Toxicity Testing

Benthic tests are conducted to evaluate the potential adverse toxicological impacts of dredged materials on the benthic community. These tests involve exposing organisms to test sediments and comparing the test organism responses with those exposed to the Control/reference sediments. The 2 species proposed for benthic testing (the amphipod, *Ampelisca abdita* and the polychaete, *Neanthes arenacoedentata*) exhibit 3 functional characteristics that represent important ecological usages of the benthic habitat: filter feeding, deposit feeding, and burrowing.

These tests will be performed using ASTM methods E1367-99 and E1611-00 for the amphipods and polychaetes, respectively. Ammonia and sulfide concentrations will be monitored in sediments immediately prior to setting up of each round of tests. If the ammonia or total sulfide concentrations in the bulk sediment interstitial waters (porewaters) exceed the recommended concentrations of 15 mg/L total ammonia (PN 99-3), or the calculated target value for the total sulfide (<0.56 mg/L at pH 7.5 [Knezovich et al., 1996]), then pre-test water exchanges (purging) will be required in order to reduce the ammonia and/or sulfide concentrations. In addition, if sediment porewater salinity is <25 ppt, salinity adjustment will be performed to bring the porewater salinity to >25 ppt.

If purging is necessary, it will begin immediately and will be applied to all replicates for all treatments including the negative control and reference sediments. Ammonia or sulfides will be purged by manually exchanging the overlying seawater in each test chamber twice daily. Once all total ammonia concentrations are at or below 15 mg/L, and/or total sulfide concentrations are below the calculated target value, the sediment test replicates will be loaded with test organisms and the tests will be initiated. Overlying water ammonia and/or sulfide concentrations will be monitored at test initiation (Day 0) and termination (Day 10). Salinity, pH, and temperature of the overlying water will also be measured at the test initiation and termination so that the un-ionized ammonia concentration can be calculated.

5.2.1.1 Amphipod Solid-Phase Survival Bioassay - One of the benthic test species will be the tube-dwelling amphipod *Ampelisca abdita*, with test organisms being collected from Narragansett, RI, or from San Francisco Bay, depending upon availability. All of the amphipods used in the project will be from one location to control for potential geographical genetic variability. Native “Home” control sediment will also be obtained from the amphipod collection site.

Amphipod tests will be conducted as 10-day (acute) static exposures, with 5 replicates per treatment (the LRTC composites, the “Home” sediment Control, and the SF-10 and SF-11 reference sites). Each replicate will consist of a 1-L glass jar containing ~4 cm of sediment and ~800 mL of clean overlying seawater at ~30 ppt. The test conditions include exposure at 20 ± 1°C under continuous light. The tests will be initiated with the random allocation of 20 randomly-selected test organisms into each replicate. Water quality parameters, including pH, temperature, dissolved oxygen (D.O.), and salinity, will be measured daily during testing.

The tests will be terminated after 10 days exposure. The test endpoint is survival, with the test response for the Site Composite being compared to the reference sediments for determination of potential impairment.

Reference Toxicant Testing - In order to assess the sensitivity of the amphipods used in these tests to toxic stress, a reference toxicant test will be run concurrently with the whole sediment amphipod test. The *Ampelisca* reference toxicant test consist of a 96-hour, water-only exposure to cadmium (as $CdCl_2$). The test response data for cadmium are then compared to the ongoing database of response data from previous reference toxicant tests performed by the laboratory.

5.2.1.2 Polychaete Solid-Phase Survival Bioassay - The second benthic test species will be the marine polychaete *Neanthes arenacoedentata*, obtained from an ongoing culture maintained by Dr. Donald Reish at Long Beach State University. Control sediment will also be collected from a site free from contamination and of known quality to produce acceptable survival.

Polychaete tests will be conducted as 10-day (acute) static exposures, with 5 replicates per treatment (the LRTC composites, the Control sediment, and the SF-10 and SF-11 disposal reference sites). Each replicate will consist of a 1-L glass beaker containing ~2.5 cm of sediment and ~800 mL of clean overlying seawater at ~30 ppt. The test conditions include exposure at 20 ± 1°C under a 12L:12D photoperiod. The tests will be initiated with the random allocation of 10 randomly-selected test organisms into each replicate. Water quality parameters, including pH, temperature, D.O., and salinity, will be measured daily during testing.

The tests will be terminated after 10 days exposure. The test endpoint is survival, with the test response for the Site Composite being compared to the reference sediments for determination of potential impairment.

Reference Toxicant Testing - In order to assess the sensitivity of the polychaetes used in these tests to toxic stress, a reference toxicant test will be run concurrently with the whole sediment polychaete test. The *Neanthes* reference toxicant test consist of a 96-hour, water-only exposure test using cadmium (as $CdCl_2$). The test response data for cadmium are then compared to the ongoing database of response data from previous reference toxicant tests performed by the lab.

5.2.1.3 Statistical Analyses for the Benthic Sediment Toxicity Tests - The Control treatment acceptability criteria for survival is ≥90% survival in the "Home" sediment treatment for both amphipods and polychaetes. The test organism survival data will be analyzed to determine if there are any statistically significant reductions in survival in the LRTC sediments relative to the appropriate control treatments. All statistical analyses will be performed using CETIS® (Version 1.1.1a, TidePool Scientific, McKinleyville, CA). A toxicologically significant effect in the sediment bioassays is defined as a statistically significant reduction in survival and a >20% reduction in survival for amphipods or >10% reduction in survival for polychaetes, relative to their respective reference site treatments.

5.2.2 Water Column *Mytilus sp.* Embryo-Larval Development Bioassay

Disposal regulations require water-column evaluations of the sediment elutriate using either bivalve or echinoderm larvae. Sediment elutriate tests will be performed using bivalve (*Mytilus sp.*) embryos as described in ASTM method E724-98.

Elutriate toxicity samples will be prepared as per ITM procedures, mixing a slurry of 1 part sediment to 4 parts Site Water for 30 minutes, followed by a 60 minute settling period (post-settling centrifugation may be implemented, if necessary to remove suspended fines). The resulting supernatant is considered 100% elutriate. The Control water for these tests will consist of 0.45-μm-filtered clean seawater (from the U.C. Bodega Bay Marine Laboratory), diluted to ~30 ppt salinity via addition of reverse-osmosis, de-ionized water. The 100% elutriate and the Control water will be used to prepare test solutions at concentrations of 1%, 10%, and 50% elutriate. If ammonia concentrations in the bulk sediment exceed 15 mg/L total ammonia-N, an additional 25% elutriate concentration may be included in the bivalve embryo-larval test; this additional concentration has proven useful in the past in differentiating between chemical-related effects and ammonia-related effects. Routine water quality characteristics will be determined for each test solution prior to use in these tests.

There will be 5 replicates for each treatment, each replicate consisting of 10-mL of test solution within a 20-mL glass scintillation vial. The tests will be initiated by the random allocation of

150-300 embryos into each test replicate, which will then be placed into a temperature-controlled water bath at 16°C under a 16L:8D photoperiod.

After ~48 hrs exposure, the tests will be terminated, and the contents of each test replicate vial will be preserved via addition of 5% glutaraldehyde. The preserved embryos will be examined microscopically to determine the percentage survival and percentage normal embryo development of the test organisms.

Reference Toxicant Testing - In order to assess the sensitivity of the *Mytilus sp*. embryos used in these tests to toxic stress, a reference toxicant test will be run concurrently with the elutriate tests. The reference toxicant tests consist of a 48-hour, water-only exposure to copper (as $CuSO_4$). The % normal embryo development test response data for copper are then compared to the ongoing database of response data from previous reference toxicant tests performed by the lab.

5.2.2.1 Statistical Analyses for the Water Column Toxicity Tests - The test acceptability criteria for Control treatment are ≥70% survival and ≥70% normal development. Key point estimates (e.g., LC_{50} and EC_{50} values) will be determined for the elutriate tests following the EPA statistical analysis flowchart. All statistical analyses will be performed using CETIS®.

5.3 Quality Assurance (QA) Objectives

Quality assurance procedures to be used for sediment testing are consistent with methods described in USEPA/USACE (1995, 1998) and USEPA (1998). The methods employed in this sediment sampling and characterization program are detailed in standard guides (*e.g*., Standard Methods, ASTM, USEPA, etc.) and Standard Operating Procedures are maintained in the bioassay and analytical laboratories.

All QA/QC records for the various testing programs are kept on file for review by regulatory personnel.

5.3.1 Chemical and Physical Analyses Quality Assurance

5.3.1.1 Accuracy - Accuracy estimates will be based on analyses of lab blanks, analytical recoveries of matrix spikes of test samples and laboratory control materials, and analysis of certified reference material. Results from spikes and/or reference materials are reported as "percent recovery", determined by comparing the measured analyte concentrations of the Standard Reference Materials, Laboratory Control Materials, or matrix spikes to the "True Value". Percent Recovery will be reported along with the corresponding acceptance ranges (based on US EPA Methods tables or plus or minus three times the standard deviation of a minimum of 20 previous comparable True Value % recoveries for the laboratory). Where possible, surrogate compounds will be spiked into each sample and surrogate percent recovery will be reported along with the corresponding control limits (based on three times the standard deviation of a minimum of 20 previous results from the same matrix as the project samples). QA charts of the surrogate recovery results for each sample will be created and will also contain the control limits.

Matrix spikes are added prior to processing the sample and carried through the entire analytical procedure. Matrix spike data for both trace metals and organics will be provided at a frequency of one set of duplicate spikes per QA batch. Accuracy assessment of matrix spikes will be targeted on those analytes that are present at low levels in the field samples. The trace organic spikes will be based upon a subset of the total list of target analytes, but will not be less than 5 compounds per analytical group (e.g., a minimum of 5 PCB congeners and 5 PAHs).

5.3.1.2 Precision - Precision will be estimated by analyzing duplicate samples and matrix spike duplicate samples. Duplicate analyses are performed on actual site samples and not on reference site samples. Results from duplicate analyses of the actual test samples may also indicate homogeneity of the sample matrix. Relative percent differences (RPDs) are calculated for all duplicate samples or spikes and are reported along with acceptance ranges (typically 0-30%).

5.3.1.3 Analytical Methods - All sample analyses will be performed using EPA Methods, where applicable (see above for method specification for each analysis group). Daily logs of instrument performance are maintained, including initial and continuing calibration verification.

5.3.2 Biological Testing Quality Assurance

All sediment toxicity tests will incorporate standard toxicity testing QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls (reference toxicant tests), reference sediment samples, replicates, and measurements of water quality during testing.

5.3.2.1 Water and Sediment Handling and Storage - Sediment samples will be maintained at 4°C in the dark until they are used in the bioassay testing system. All sediments are held in sealed, labeled sample storage bags. Site water samples will be similarly stored in sealed, labeled containers at 4˚C. Seawater used in these tests will come from the UC Davis Bodega Bay Marine Laboratory (Bodega Bay, CA), and will be stored on-site at PER in an insulated 4,500 gallon HDPE tank at 4˚C. Sub-samples designated for long-term storage are archived under the appropriate holding conditions.

5.3.2.2 Source and Condition of Test Organisms - All test organisms will be obtained from reputable suppliers who have provided PER with organisms in the past. Normally, all test organisms are maintained in the laboratory for acclimation to test conditions (exceptions are bivalves). If mortality in excess of 5% is noted in the holding stock, the animals will be discarded and a new batch ordered.

5.3.2.3 Maintenance of Test Conditions and Corrective Actions - Each of the biological tests has a set of specific test conditions that are defined in the standard testing. For example, water quality measurements will be monitored to ensure that test conditions are within the prescribed limits for each test procedure. The limits for various test condition parameters are noted in the section on the acceptability of each test. If these criteria are not met, the test will be re-run if appropriate.

5.3.2.4 Calibration Procedures and Frequency - Instruments are calibrated daily according to Laboratory (SOPs) and calibration data are logged and initialed. Calibration logs are monitored weekly to ensure completeness.

5.3.2.5 Reference Toxicant Testing and Data Accuracy and Precision - The accuracy of toxicity tests (e.g., LC_{50} point estimates) are not normally measured in biological testing, since "duplicate" toxicity tests are not performed. Instead, concurrent reference toxicant tests are used to assess accuracy and precision. For instance, acceptable accuracy is defined as a current measured LC_{50} reference toxicant value that is within 2 standard deviations of the current laboratory mean established by previously-performed reference toxicant tests. A reference toxicant will be performed concurrently with the testing for each species to establish that the test organisms are responding to toxic stress in a typical fashion.

The precision of toxicity tests is assessed via measures of variability (e.g., coefficient of variation [CV] for a given test treatment). While there are no "acceptability limits" placed on the CV for most test responses, these can be evaluated using "Best Professional Judgment" to characterize whether or not the test response at a given treatment is subject to too much variability for use in a given test.

5.3.2.6 Data Evaluations - Bioassay tests are performed according to accepted protocols and standard test conditions. All test data, data analyses, and other relevant records for each test will be reviewed for accuracy and completeness by the quality control unit. Deviations from the standard testing guides are reported with the final report. If and when such deviations are observed, the test will be evaluated to determine whether it is valid according to the regulatory agency to which it will be submitted. If it is determined to be invalid, the client will be notified and the test rerun.

5.3.2.7 Sample Tracking - Sample COC sheets, sample receipt logs, sample holding, and sample labeling procedures are audited weekly by the quality control unit. Sub-samples designated for long-term storage are archived under the appropriate holding conditions.

5.3.3 Deviations from Protocol

Any deviations from approved SOP's or this SAP will be summarized and qualified with respect to how they may have affected data quality.

6. DATA MANAGEMENT

Analytical results will be provided by all subcontract analytical laboratories in both hard copy and electronic format. All data will be reviewed by the PER Project Manager to ensure that the data quality objectives for each analysis are met and that both the electronic and hard copy forms of data are accurate. Hard copies of all data reports will be placed in the project files at PER; electronic data reports will be archived on PER's server, and will be available for electronic transfer to LRTC and the DMMO, if requested.

7. DATA ANALYSIS AND INTERPRETATION

Data will be analyzed and presented clearly so that suitability for disposal at SF-11 can be determined. All analytical data will be reviewed for accuracy prior to reporting; data will be presented in tabular form. The physical and chemical characteristics of sediment samples will be evaluated according to the DMMO review process. Benthic sediment toxicity test results will be compared to the reference station composite according to the DMMO review process; water column toxicity test results will be compared to Elutriate Suitability Concentrations (ESC) at the edge of the mixing zone for the SF-11 Disposal Sites.

7.1 Sediment Chemistry and Conventional Data Analyses

Sediment physical and chemical characteristics provide information about chemicals of concern present in the sediment and their potential bioavailability, and about non-chemical factors that could affect toxicity. Data analysis of sediment chemistry and conventional parameters will consist of tabulation and comparison with existing regulatory guidelines (USEPA/USACE 1998) as requested by the DMMO. Sediment chemistry results will also be used to identify localized "hot spots" which may need further resolution (e.g., analysis of sediment material from individual cores), and/or to assist in evaluating appropriate disposal options).

7.2 Benthic Toxicity Test Data

ITM guidance requires that test sediment results be compared with disposal site and/or reference site sediment results to determine the potential impact of whole sediment on benthic organisms at and beyond the boundaries of the disposal site (USEPA/USACE 1998). As detailed in the ITM, comparative guidelines for acceptance are listed below:

1. If survival is greater in the proposed dredged sediments than in reference site sediment(s), the proposed dredged sediments are <u>not</u> acutely toxic to benthic organisms.
2. If the difference between test sediment survival and reference sediment survival is $\leq$20% for amphipods or $\leq$10% for polychaetes, the test sediments are <u>not</u> acutely toxic to benthic organisms.
3. If the difference between test sediment survival and reference sediment survival is >20% for amphipods or > 10& for polychaetes), then survival in the test sediment must be compared statistically to survival in the reference sediment. If a statistically significant reduction in survival is then observed for the proposed dredged sediment treatment, then the test sediments are considered to be acutely toxic to benthic organisms.

7.3 Water Column (Sediment Elutriate) Toxicity Test Data

Comparative guidelines for interpretation of water column tests, as detailed in the ITM, are listed below:

1. If survival in the 100% sediment elutriate treatment is $\geq$ than survival in the Control (clean seawater) treatment, the dredged material is not predicted to be acutely toxic to water column organisms.
2. If the reduction in survival in the 100% sediment elutriate treatment is $\leq$10% relative to the Control treatment response, there is no need for statistical analyses and no indication of water column toxicity attributable to the test sediments.
3. If the reduction in survival in the 100% sediment elutriate is >10% relative to the Control treatment response, then data must be evaluated statistically to determine the magnitude of toxicity. If there is >50% survival or normal embryo development in the 100% elutriate treatment, the LC_{50}/EC_{50} is assumed to be $\geq$100%. If there is <50% survival or normal embryo development in at least one of the elutriate treatments, then an LC_{50}/EC_{50} should be calculated and compared with existing acceptability standards.

7.3.1 Dilution Model Calculations

The Short Term Fate Model for open water barge and hopper discharges will ultimately be used to model the fate of disposed sediments and determine if the concentrations of chemicals of concern will meet water quality criteria at the edge of the mixing zones for the various disposal sites in San Francisco Bay; input parameters, unique to each site, are currently being developed. The dilution model currently used to calculate the concentration of sediment at the edge of the mixing zone uses the results of both grain size analysis (% clay and % silt) and water-column bioassay tests (LC_{50}/EC_{50}) to determine if the concentration of dredge material that is swept away from the barge will result in an exceedance at the edge of the disposal site mixing zone. A sample will exceed water quality criteria if 1% of the calculated LC_{50} or EC_{50} (whichever is more conservative) is lower than the projected suspended phase concentration of the dredge material at the edge of the mixing zone.

8. REPORTING AND DELIVERABLES

8.1 Sampling and Analysis Results

PER will prepare a Final Sampling & Analysis Data Report documenting all activities associated with the collection, transportation, handling (e.g. compositing), sample shipment, and chemical and conventional analyses, and biological testing of the sediment samples. All Lab Data Reports received from sub-contracting analytical laboratories will be included as Appendices to the Final Data Report. At a minimum, the following will be included in the Final Data Report:

1. Summary of all field activities, including a description of any deviations from the approved SAP;
2. Locations of sediment sampling stations in latitude and longitude (in degrees and minutes to 3 decimal places). All vertical elevations of mud-line and water surface will be reported to the nearest 0.1 ft relative to MLLW;
3. A project map with actual sampling locations;
4. Analytical data results and QA/QC review;
5. Summary of comparison of chemical results.

9. REFERENCES

Knezovich, J.P., D.J. Steichen, J.A. Jelinski, and S.L. Anderson. 1996. Sulfide tolerance of four marine species used to evaluate sediment and pore-water toxicity. Bull. Environ. Contam. Toxicol. (1996) 57:450-457. Springer-Verlag, New York, NY.

Plumb, R.H., Jr., 1981. Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report U.S.EPA /CE-81-1, prepared by Great Lakes Laboratory, State University College at Buffalo, Buffalo, NY, for the U.S. Environmental Protection Agency/Corps of Army Engineer Waterways Experiment Station, Vicksburg, MS.

Krone, C.A., D.W. Brown, D.G. Burrows, R.G. Bogar, S.L. Chan, and U. Varanasi. 1989. A method for analysis of butyltin species and the measurements of Butyltins in sediment and English sole livers from Puget Sound. Mar. Environ. Res.27:1-18.

U.S.EPA/ACOE. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Materials Evaluations. U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. EPA/823/B-95/001. Office of Water. Washington, DC. EPA-823-B-95-001. April 1995.

U.S.EPA/ACOE.1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual (Inland Testing Manual). U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. EPA/823/B-94/002. Office of Water. Washington, DC 20460.

U.S.EPA. 1998a. EPA Requirements for Quality Assurance Project Plans. United States Environmental Protection Agency, Quality Assurance Division, Washington, DC. 20460.

U.S.EPA. 1998b. EPA Guidance for Quality Assurance Project Plans. United States Environmental Protection Agency, Office of Research and Development, Washington, DC 20460.

Appendix A

Sample Containers, Holding Time, Preservation and Storage for Analytical Chemistry

SAMPLE CONTAINERS, HOLDING TIMES, PRESERVATION AND STORAGE

PARAMETER	CONTAINER TYPE/SIZE	HOLDING TIME[a]	PRESERVATION/STORAGE
Metals[b]	125-ml glass jar	Mercury – 28 days All others – 6 months	Hold at 4°C ± 2°C up to 1 month or freeze at -20°C ± 10°C
Butyltins	500-mL glass with Teflon® lid	14 days to extraction[c]; 40 days to analysis after extraction	Freeze for extended storage (-20°C ± 10°C); otherwise store at 4°C ± 2°C
PCBs[d], pesticides[e], PAHs[f]	500-mL glass with Teflon® lid	14 days to extraction[c]; 40 days to analysis after extraction	Freeze for extended storage (-20°C ± 10°C); otherwise store at 4°C ± 2°C
Grain size	125-ml plastic	6 months	4°C ± 2°C
Total solids, TOC, ammonia	250-ml glass with Teflon® lid	Total solids, TOC – 1 month; ammonia – 7 days	4°C ± 2°C
Toxicity tests	4-L glass with Teflon® lid (1 container per acute test)	6 weeks	4°C ± 2°C/dark/airtight
Archive	500-mL and 1-L glass jars with Teflon® lid (for composite samples)	1 year	Freezer storage (-20°C ± 10°C)

NOTE: PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
TOC – total organic carbon

[a] Holding times begin the day the sediment sample is prepared in the filed.
[b] Arsenic, cadmium, chromium, copper, lead , mercury, nickel, selenium, silver, and zinc.
[c] Sample may be held for up to one year if stored at -20°C±10°C (USEPA/USACE 1998).
[d] PCBs as congeners, Aroclors 1242, 1248, 1254, 1260, and total PCBs (USEPA/USACE 1998).
[e] Chlorinated pesticides on USEPA Method 608 list (USACE 1993; USEPA/USACE 1998).
[f] PAH compounds on USEPA Method 610 list (USACE 1993; USEPA/USACE 1998).

Appendix B

Analytical Chemistry Methods and Reporting Limits

ANALYTES, ANALYSIS METHODS, AND TARGETED DETECTION LIMITS

"Conventional" Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Grain size	ASTM 1992, Plumb 1981	0.1%	0.1%
Total solids	SM2540B	0.1%	0.1%
Total organic carbon	Plumb, 1981	0.1 %	0.01 %

Metal Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Arsenic	Method 6020	2.0 mg/kg	0.05 mg/kg
Cadmium	Method 6020	0.3 mg/kg	0.01 mg/kg
Chromium	Method 6020	5.0 mg/kg	0.05 mg/kg
Copper	Method 6020	5.0 mg/kg	0.01 mg/kg
Lead	Method 6020	5.0 mg/kg	0.01 mg/kg
Mercury	Method 6020	0.02 mg/kg	0.005 mg/kg
Nickel	Method 6020	5.0 mg/kg	0.01 mg/kg
Selenium	Method 7740	0.1 mg/kg	0.05 mg/kg
Silver	Method 6020	0.2 mg/kg	0.01 mg/kg
Zinc	Method 6020	1.0 mg/kg	0.05 mg/kg

Organotin Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Butyltins	Rice et al.	10 μg/kg	2 μg/kg

PCB Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Aroclor 1016	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1221	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1232	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1242	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1248	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1254	Method 8270 (mod)	20 μg/kg	20 μg/kg
Aroclor 1260	Method 8270 (mod)	20 μg/kg	20 μg/kg
Congeners (if required)	Method 8270 (mod)	20 μg/kg	2 μg/kg
Total PCBs	Method 8270 (mod)	-	-

Pesticide Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Aldrin	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
a-BHC	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
b-BHC	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
g-BHC (Lindane)	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
d-BHC	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Chlordane	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
2,4'-DDD	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
4,4'-DDD	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
2,4'-DDE	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
4,4'-DDE	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
2,4'-DDT	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
4,4'-DDT	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Dieldrin	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Endosulfan I	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Endosulfan II	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Endosulfan sulfate	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Endrin	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Endrin aldehyde	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Heptachlor	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Heptachlor epoxide	Method 8270 (mod)	2.0 μg/kg	2.0 μg/kg
Toxaphene	Method 8270 (mod)	20 μg/kg	20 μg/kg

PAH Analytes	Analytical Method	Reporting Limit (dry weight)	
		DMMO	CAS
Acenaphthene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Acenaphthylene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Anthracene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Benz(a)anthracene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Benzo(a)pyrene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Benzo(b)fluoranthene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Benzo(g,h,i)perylene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Benzo(k)fluoranthene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Chrysene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Dibenz(a,h)anthracene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Fluoranthene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Fluorene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Indeno(1,2,3-cd)pyrene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Naphthalene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Phenathrene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg
Pyrene	Method 8270 (mod)	20 μg/kg	2.0 μg/kg

Appendix C

Standard Operating Procedures

STANDARD OPERATING PROCEDURE

SEDIMENT CORE/SAMPLE COLLECTION – VIBRACORER

Sediment core samples may be collected with an electrically powered vibracorer, which is lowered through the water column under winch control, and which penetrates the sediment by means of its weight and intense vibration. The following steps outline the procedure for collection of sediment samples using a vibracorer.

1. Maneuver the sampling vessel to the proposed sampling location using the navigation system and deploy a marker buoy at the location.

2. Check to ensure that the metal core barrel is securely fastened to the powerhead of the vibracorer and insert a decontaminated core liner inside the metal core barrel.

3. Insert a core catcher in to the core nose so that the catcher fingers will extend into the core liner, and then screw the core nose onto the bottom of the core barrel.

4. Continue screwing the core nose until the shoulder on the inside of the core nose firmly contacts the end of the core barrel. Tighten the core nose with a spanner or strap wrench.

5. Start the electrical generator, but **DO NOT** energize the corer.

6. Signal the winch operator to hoist the corer and swing it over the stern or side of the vessel at the marked sampling location. Reposition the vessel if necessary. Record the measured water depth, and enter the tidal elevation on the core collection log sheet. Calculate the mudline elevation, and then determine the number of feet of penetration required to reach project depth.

7. Signal the winch operator to lower the corer through the water column. Determine the depth of the corer in the water column and track its subsequent penetration into the sediment either by marking the winch line in 1-ft increments or by attaching a flexible tape measure to the powerhead. In either case, the reference will be 0 ft at the tip of the core nose.

8. When the core nose is within approximately 10 ft of the bottom, energize the corer by actuating the circuit breaker on the generator control panel.

9. Slow the descent speed of the corer in order to determine when the core nose is entering the sediment. Maintain tension on the winch line throughout the coring process to keep the corer from topping over. The worker monitoring the penetration of the corer into the sediment will signal the winch operator when to pay out more line.

10. If refusal is encountered or if the measured distance to the tip of the core nose indicates that project depth has been reached, stop paying out line and de-energize the corer. Do not power down the generator. Refusal is indicated by less than 6 inches of penetration in a given 30-seecond interval.

11. Signal the winch operator to bring the winch line taut. Maneuver the boom or the boat until the winch pulley is directly above the corer in the sediment, as indicated by the winch line being as close to true vertical as possible.

12. Record the position of the actual coring location. The navigation antenna may be mounted on the winch boom near the pulley to place it directly over the corer.

13. Signal the winch operator to retrieve the corer. If the corer is stuck in the bottom, energize the power head while maintaining tension on the winch line. To reduce the risk of losing sediment from the core barrel, de-energize the corer over the deck and lower it to a holding rack. Note and record the length of smearing on the outside of the core barrel, which gives and indication of the amount of penetration.

14. Use a spanner or strap wrench to unscrew the core nose and remove it. The catcher may stay inside the core nose or remain attached to sediment inside the core liner. Retain any sediment in the core nose and catcher for examination and possible use.

15. Pull the corer liner approximately 6 inches out of the core barrel, remove the catcher, if necessary, and immediately cap the bottom end of the core liner with a plastic cap. Secure the bottom cap with duct tape.

16. Extract the core liner entirely from the core barrel, and immediately cap the top of the core liner.

17. If the core is to be cut into length-wise sections, draw a mark on the outside of the core liner where the cut will be made to cut off the bottommost section. Apply duct tape and use a permanent marker to mark the sections on both sides of the location of the future cut. Mark arrows pointing toward the top end of the core, write the core ID, write date and time, and indicate the depth interval spanned by the sections in terms of feet below mudline.

18. Three individuals are needed to complete the cutting process: One person will make the cut with a saw loaded with a decontaminated blade, and two persons will tend the cut ends of the sections.

19. Make the cut and immediately cap both the exposed ends. Immediately secure both caps with duct tape.

20. Repeat the cutting procedure if more length-wise sections need to be cut.

21. Remove the cap from the top end of the top-most section and drain the water. Draining may be accomplished by drilling the hole through the core liner just above the top of the sediment or by gently tipping the section to empty the water out the top. The latter approach may be risky if the sediments are watery or loose.

22. Cut off the excess plastic tube and immediately cap the end and secure the cap with duct tape.

23. If the core will consist of only one section, do steps 15 and 16, mark the core liner as described in step 17, and then do steps 21 and 22.

24. Evaluate the appearance and length of the core sample by examination through the clear plastic core liner. Note any stratigraphic intervals or other salient features on the core collection log sheet.

25. Fill out a chain-of-custody form for the core section(s) to initiate the tracking process.

26. Store the core sections at 4°C (± 2°C) in a refrigerator or iced cooler.

27. Complete any additional entries on the core collection log sheet.

Acceptance criteria for a sediment core sample are as follows:

- The core penetrated to and retained material to project depth or refusal and shows evidence of Merritt Sand.

- Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.

- There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core and resulted in incomplete core collection.

If sample acceptance criteria are not achieved, the sample will be rejected. If repeated deployment within 25-50 ft of the proposed location does not result in a sample that meets the appropriate acceptance criteria, the Project Manager will make a decision regarding relocating the proposed sample location.

STANDARD OPERATING PROCEDURE

LABORATORY SEDIMENT CORE/SAMPLE PROCESSING

The following steps outline the general procedure to be followed. The number and subdivisions of berths and composites may vary, depending upon a particular sampling episode.

1. All equipment coming into contact with sediment will be decontaminated before use with each sample to avoid cross contamination.

2. Extrude the sediment from the core liner into a stainless-steel bowl or a 5-gallon high-density polyethylene (HDPE) bucket, depending on the volume.

3. Examine the sediment and record descriptive notes on the core collection log sheet. Parameters may include:
    a. Qualitative sediment description.
    b. Odor
    c. Debris
    d. Biological activity (e.g., detritus, shells tubes, bioturbation, live or dead organisms)
    e. Presence of oil sheen
    f. Any other distinguishing characteristics

4. After the sediment description is complete, homogenize the sediment by hand using a stainless-steel mixing spoon or by using an electric drill with a stainless-steel stirring paddle.

5. Once the sediment has been homogenized, immediately collect a sample for sulfide analysis prior to any other processing. Use a stainless-steel spoon to place sediment into a 4-oz jar. Fill the jar two-thirds full and preserve with one vial of zinc acetate supplied by the analytical laboratory. Immediately screw on the lid, label the jar, and place it in a cooler supplied with ice or frozen blue ice packets.

6. Collect a sample of the homogenized sediment from the individual core for archiving. Fill one 16-oz sample container three-fourths full, screw on the lid, label the jar, and place it in freezer storage for archival purposes.

7. Use aluminum foil or a filtered lid to close the container of homogenized sediment until the remaining cores of the group to be composited for that site have been similarly processed.

8. In a 10-gallon HDPE bucket, combine equal portions of sediment from each individual core of the group to be composited and mix thoroughly (e.g., with an electric drill and stainless-steel paddle) until uniformly homogenized.

9. Collect a sample of the homogenized composite for archiving by filling a 32-oz sample jar three-fourths full, screwing the lid on tightly, labeling the jar, and placing it in freezer storage.

10. Distribute the composited homogenized site sediment to the appropriate sample jars, label the jars, complete the core processing log form and sample tracking form, and place the jars in refrigerated storage for subsequent packing and shipping to analytical laboratories.

11. If it is necessary to archive sediment for possible use in bioassays, ensure that all sample jars for analysis have been filled, then collect two 64-oz glass containers per bioassay.

12. Throughout the sample processing phase, maintain secure storage of sediment and samples; that is, observe proper custody procedures, and continue those procedures until the sample shipping containers are released to the shopping carriers.

13. Any sediment remaining from individual cores that was not used in preparing the homogenized composite should be archived at 4°C for potential subsequent analysis of the individual cores.

Appendix D

Bioassay Standard Test Conditions

SUMMARY OF TEST CONDITIONS AND ACCEPTABILITY CRITERIA FOR THE AMPHIPOD (*Ampelisca abdita*) 10-DAY SEDIMENT TOXICITY TEST		
1.	Test type	Static non-renewal
2.	Test duration	10 d
3.	Temperature	20 ± 1°C
4.	Salinity	20 – 35 ppt
5.	Light quality	Ambient Laboratory
6.	Light intensity	50 – 100 ft c.
7.	Photoperiod	Continuous
8.	Test chamber size	1 L
9.	Seawater volume	800 mL
10.	Sediment depth	40 mm
11.	Renewal of seawater	None
12.	Age of test organisms	Wild population, immature juveniles
13.	# of organisms per test chamber	20
14.	# of replicate chambers/concentration	5
15.	# of organisms per sediment type	100
16.	Feeding regime	None
17.	Test chamber cleaning	Lab washing prior to test
18.	Test solution aeration	Low bubble (~100/minute)
19.	Overlying water	0.45 μm-filtered seawater (at test salinity)
20.	Test materials	Test sites, reference and control
21.	Dilution series	None
22.	Endpoint	% Survival
23.	Sample holding requirements	< 8 weeks
24.	Sample volume required	4 L
25.	Test acceptability criteria	≥ 90% survival in the Control treatment
26.	Reference toxicant results	Within 2 SD of laboratory mean

SUMMARY OF TEST CONDITIONS AND ACCEPTABILITY CRITERIA FOR THE MARINE POLYCHAETE (*Neanthes arenacoedentata*) 10-DAY SEDIMENT TOXICITY TEST		
1.	Test type	Static-renewal
2.	Test duration	10 d
3.	Temperature	20 ± 1°C
4.	Salinity	20 – 35 ppt
5.	Light quality	Ambient Laboratory
6.	Light intensity	50 – 100 ft c.
7.	Photoperiod	12L/12D
8.	Test chamber size	1 L glass beakers
9.	Test solution volume	800 L
10.	Sediment depth	25 mm (200 mL)
11.	Renewal of seawater	None, unless needed. If needed, renew 80% of overlying water at 48 hour intervals
12.	Age of test organisms	2-3 weeks
13.	# of organisms per test chamber	10
14.	# of replicate chambers/concentration	5
15.	# of organisms per sediment type	25
16.	Feeding regime	None
17.	Test chamber cleaning	Lab washing prior to test
18.	Test solution aeration	Low bubble (~100/minute)
19.	Overlying water	0.45 μm-filtered seawater, at test salinity
20.	Test concentrations	Test sites, reference and Control
21.	Dilution series	None
22.	Endpoint	Survival
23.	Sample holding requirements	< 8 weeks
24.	Sample volume required	4 L
25.	Test acceptability criteria	≥ 90% survival in the Control treatment
26.	Reference toxicant results	Within 2 SD of laboratory mean

SUMMARY OF TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA FOR THE MUSSEL (*Mytilus sp.*) ACUTE TOXICITY WATER COLUMN TEST		
1.	Test type	Static non-renewal
2.	Test duration	48 hours
3.	Salinity	28 – 32 ppt
4.	Temperature	16 ± 1°C (mussels)
5.	Light quality	Ambient Laboratory
6.	Light intensity	50 –100 ft c.
7.	Photoperiod	16L/8D
8.	Test chamber size	20 mL vials
9.	Test solution volume	10 mL
10.	Renewal of seawater	None
11.	Age of test organisms	Embryo ≤ 4h old
12.	# of organisms per test chamber	150 – 300
13.	# of replicate chambers per concentration	5
14.	# of organisms per concentration	750 – 1,500
15.	Feeding regime	None
16.	Test chamber cleaning	Lab washing prior to test
17.	Test chamber aeration	None
18.	Elutriate preparation water	Site water
19.	Test concentrations	Test sites, and control
20.	Dilution series	Four concentrations (1, 10, 50, 100%) and a Control.
21.	Dilution water	Natural seawater
22.	Endpoints	%Survival and %normal development
23.	Sampling holding requirements	< 8 weeks
24.	Sample volume required	2L
25.	Test acceptability criteria	≥70% survival and normal development in the controls, <10% abnormal in control